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Flood impact on men's mental health: evidence from flood-prone areas of Bangladesh

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Disasters can pose significant risks to mental health, often resulting in both temporary and long-lasting psychological distress. This study explores the impact of floods on mental health. A survey was conducted shortly after the 2022 flash flood, in which 452 male participants from the Ajmiriganj and Dharmapasha Upazilas in Bangladesh were surveyed. Mental health was assessed using the DASS-21 instrument, and we examined the variables associated with mental health issues. Descriptive statistics and multiple linear regression analysis were employed. Around 47% of participants reported severe or extremely severe depression, 41% reported severe or extremely severe anxiety, and 36% reported severe or extremely severe stress. Factors such as age, marital status, type of home, occupation, flood safety rating, and property loss during the 2022 flood were all found to be associated with depression. Anxiety was linked to flood safety, occupation, housing type, education level, and marital status. Additionally, all anxiety-related variables were also associated with stress. Mental health issues were more prevalent among older, married, illiterate participants living in kacha (temporary) housing, as well as among agricultural workers and fishers with low safety ratings. Psychological interventions and disaster risk reduction strategies could help mitigate the mental health impact of floods. The findings of this study have important implications for global disaster management and public health.

KEYWORDS

flash flood, mental health, stress, anxiety, depression, Bangladesh

1 Introduction

Southeast Asia is highly vulnerable to floods, yet it often lacks the flood-resilient infrastructure necessary to minimize damage and loss (1). Between 1960 and 2015, floods worldwide resulted in the deaths of 35,000 people, with the majority of these fatalities occurring in developing Southeast Asian nations (2). The Ganges Basin's annual monsoon floods have consistently devastated impoverished, developing countries in South Asia (3). Bangladesh, in particular, is prone to floods, cyclones, droughts, salinity intrusion, landslides, and riverbank erosion (2, 4). The country's monsoon floods are a regular occurrence, and recent devastating floods in 2017, 2019, 2020, 2021, and 2022 have severely affected its way of life and economy (5–7). The 2017 flood alone affected eight million people, destroying homes, buildings, livestock, and crops (8).

In 2022, northeastern Bangladesh experienced one of the most catastrophic flash floods in recent history (9). The districts of Sylhet and Sunamganj were among the hardest-hit areas, with water levels rising rapidly and submerging entire communities. Ajmiriganj and Dharmapasha Upazilas faced extreme flooding that persisted for several weeks. The flood resulted in massive displacement, extensive damage to homes, loss of agricultural land, and disruptions in transportation and communication. Many residents were left without food, clean drinking water, or access to healthcare, further exacerbating the disaster's impact on their physical and mental well-being. Given the scale and severity of this flood, understanding its mental health consequences is crucial for informing disaster response strategies.

While the environmental and economic consequences of floods are well-documented, the psychological toll, particularly on mental health, is becoming increasingly evident. Several studies have shown that flood victims are at risk of developing significant mental health issues, including anxiety, stress, depression, and posttraumatic stress disorder (PTSD) (7, 10–15). Factors such as the loss of loved ones, displacement, property damage, crop and agricultural losses, food insecurity, and livelihood disruptions contribute to the mental health challenges faced by flood survivors. In some cases, survivors may also exhibit suicidal tendencies (7, 15). One study found that flood victims experienced nine times higher long-term mental health problems compared to non-flood victims (16). Additionally, rising floodwater levels and a lack of flood warnings have been associated with heightened anxiety, depression, stress, and PTSD (16).

Research has shown that men and women experience different mental health risks following disasters due to variations in societal roles, coping mechanisms, and access to support systems (17). Studies consistently show that women tend to have higher rates of depression, anxiety, and PTSD following disasters. However, men also experience significant psychological distress, often manifesting in externalizing behaviors such as aggression, substance use, and social withdrawal. Societal expectations of masculinity, which discourage emotional expression and help-seeking, can exacerbate men's mental health struggles post-disaster (18, 19). The traditional perception of masculinity, which emphasizes self-reliance and emotional suppression, often discourages men from seeking psychological support, leading to the accumulation of stress and worsening mental health outcomes (20, 21). Disasters often disrupt livelihoods, financial security, and social roles—factors that disproportionately affect men in patriarchal societies where they are expected to be primary providers (22). While there is evidence that men and women may exhibit different coping strategies under stress, specific studies on gender differences in response to these disasters are limited. Generally, men are often reported to engage in more externalizing behaviors (e.g., substance use, aggression) compared to women, who might experience stress more frequently (23). While studies have consistently found that women are at a higher risk of developing PTSD compared to men after disasters, men also face substantial mental health challenges in these contexts (19, 24). Despite these risks, men are significantly less likely than women to seek professional mental health care post-disaster, which can result in long-term psychological distress (25).

While research on the gendered mental health impacts of disasters in Bangladesh is limited, global studies suggest that men's mental health challenges post-disaster should not be overlooked (24). Bangladesh is a deeply patriarchal society where traditional gender roles shape expectations for both men and women. Men are typically seen as the primary breadwinners and decision-makers, while women are expected to take on caregiving and domestic responsibilities. These societal norms influence how individuals experience and respond to disasters. During and after a crisis, men face significant pressure to restore financial stability, rebuild homes, and support their families, even when they are experiencing loss and trauma. The expectation of resilience and stoicism discourages men from openly discussing emotional distress or seeking psychological support, which can lead to prolonged mental health challenges.

Several studies show the impact of disaster on men's mental health. 66% of victims of the 1996 Tangail tornado required psychological support (26). Similarly, 25% of survivors of Cyclone Sidr in 2007 had PTSD, and 18, 16, and 15% experienced depression, somatoform disorder, and mixed anxiety/depressive disorder, respectively (26). In the aftermath of the 2022 floods, many survivors are facing mental health challenges due to economic hardships, which may lead to increased suicide risk (7). Although there are guidelines for mental health care, Bangladesh's flood mitigation programs lack comprehensive mental health standards, highlighting the need for targeted mental health support and intervention (26). This study aims to fill the gap by examining the psychological distress experienced by men in the aftermath of the 2022 flash flood in Ajmiriganj and Dharmapasha Upazilas of Bangladesh. The study has explored the mental health outcomes of men, who, despite facing unique challenges, have been largely overlooked in post-disaster mental health research. Understanding the gendered experiences of men can help tailor disaster resilience programs and mental health interventions to their specific needs.

This research uses quantitative surveys to study the psychological experiences of men in flood-prone areas. By investigating the mental health effects of the 2022 flood, this research provides crucial insights into how large-scale natural hazards affect men's psychological well-being. The findings of this study will contribute to developing targeted mental health interventions, improving disaster preparedness, and shaping future policies to address the long-term mental health consequences of such disasters in Bangladesh and beyond.

2 Methods

2.1 Study design

This study employed a cross-sectional survey design to assess the impact of the 2022 flash flood on men's mental health in two flood-prone Upazilas of Bangladesh, Ajmiriganj and Dharmapasha. We utilized the Depression, Anxiety, and Stress Scale-21 (DASS-21) to evaluate mental health conditions. A structured questionnaire was administered through face-to-face interviews to collect data on mental health status and associated sociodemographic and flood-related variables. Descriptive statistics and multiple linear regression analyses

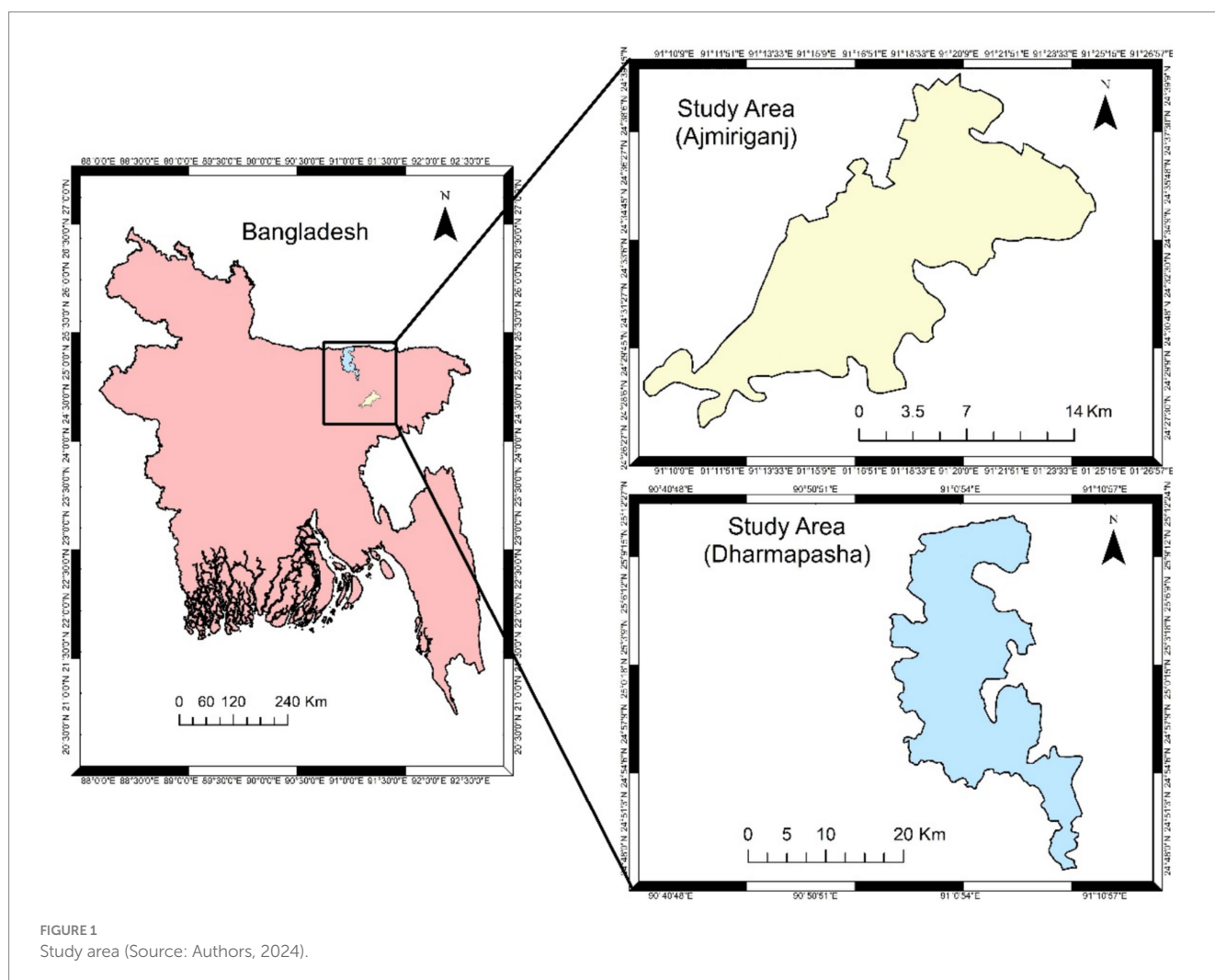
were applied to examine the association between mental health conditions and various risk factors. Ethical approval for the study was obtained from the Institutional Review Board of Khulna University.

2.2 Study area

This cross-sectional study examined the impact of the 2022 floods on two remote Upazilas of Bangladesh: Ajmiriganj and Dharmapasha. Figure 1 shows the locations of these Upazilas, with Ajmiriganj situated in the Habiganj District and Dharmapasha in Sunamganj. The rising water levels of the Khowai, Kushiyara-Kalni rivers, and haors (a type of wetland found in northeastern Bangladesh and parts of India. It is a large, bowl-shaped depression that fills with water during the monsoon season, creating a unique ecosystem. These areas are prone to seasonal flooding, which can have significant impacts on agriculture and livelihoods. Haors are vital for biodiversity, but their floods can be devastating to communities living in or near them) inundating the low-lying areas of Ajmiriganj in Habiganj District. Haors are large, bowl-shaped depressions that fill with water during the monsoon season, creating unique ecosystems. While vital for biodiversity, these areas are prone to seasonal flooding, which can severely impact agriculture and local livelihoods.

In 2022, the floods not only submerged vast areas but also cut off communication and electricity supplies to neighboring areas for several days. The floodwaters severely affected Dharmapasha Upazila, trapping people and damaging road infrastructure. Ajmiriganj Upazila has a population of 114,265, with 56,615 men and 57,650 women, covering a total area of 223.98 km² (27). The male literacy rate in Ajmiriganj is 39.5%, while the female literacy rate is 34.7% for individuals aged seven and older (27). Men in this Upazila primarily work in agriculture, while many women either stay at home or are not employed outside the household. Dharmapasha Upazila has a population of 243,464, with 122,300 men and 121,164 women, and covers an area of 531.00 km² (28). The literacy rate in Dharmapasha is 29.2%, with 30.6% of men and 27.7% of women being literate (27). The majority of residents in both Upazilas rely on agriculture for their livelihood.

The 2022 flash floods in Habiganj District affected 83,390 individuals, with Ajmiriganj being the hardest-hit area (29). The total economic loss in the district was estimated at 5000 million Bangladeshi Taka (approximately 47 million USD), with the most significant losses in infrastructure, education, livestock, agriculture, and fisheries. Most of Ajmiriganj, including its roads, was submerged, leading to a prolonged school closure (30). Similarly, the floods in Dharmapasha submerged around 965 hectares of agricultural land, leading to



significant financial losses for local farmers (31). The overall damage to crops in Sunamganj District, including Dharmapasha, amounted to one billion Bangladeshi Taka (approximately nine million USD) (32). Road closures and power disruptions further exacerbated the difficulties faced by flood victims in Dharmapasha Upazila (33).

2.3 Survey technique

We conducted a structured survey using face-to-face interviews in the local Bengali language to ensure clarity and comprehension, particularly for illiterate respondents. The questionnaire consisted of closed-ended and Likert-scale questions, including the DASS-21 instrument (34), to assess depression, anxiety, and stress levels. The survey also gathered sociodemographic information, previous flood experiences, and perceptions of flood safety.

The survey was conducted in July–August 2022, after the floodwaters had receded enough to allow access to affected areas. However, some regions were still in recovery, and the flood had a significant impact on the data collection process. Many roads remained damaged or submerged, requiring the research team to use boats and alternative routes to reach certain villages. Some participants were initially hesitant to participate due to their ongoing struggles with property loss, income disruptions, and health concerns. To address these challenges, we collaborated with local community leaders who helped facilitate participant engagement. Despite these difficulties, the survey team successfully conducted in-person interviews, ensuring that responses were gathered from a diverse group of flood-affected individuals.

Seven items comprise each subscale of DASS-21. It was used in various research (35–37). On a four-point Likert scale, 0 means “Did not apply to me at all,” 1 means “Applied to me to some degree, or some of the time-Sometimes,” 2 means “Applied to me to a considerable degree, or a good part of the time-Often,” and 3 means “Applied to me very much or most of the time-Almost always.” Participants had to describe symptoms from the previous week. Add and double the applicable item scores for depression, stress, and anxiety to get the scores. For DASS-21 scores, there are five cutoff points: normal, mild, moderate, severe, and extremely severe (Table 1). The DASS helps measure symptom severity and therapy response.

The questionnaire’s final version (in KoboToolbox) incorporates comments from a preliminary survey of certain research participants. Early survey responses were not included in the final study. Cronbach’s alphas are more than 0.80 in all three of the pretested DASS sections, indicating reliability. Current alpha values are close to previous authors’ standards (34). If the value of Cronbach’s alpha

exceeds 0.60, then the survey’s internal consistency is considered reliable (38, 39). The questionnaire has four main components. In the first part, we covered demographics (age, marital status, education, location, housing type, occupation, vulnerable family member, and chronic condition). We asked, “How do you perceive your current social life?” concerning social satisfaction. Respondents were questioned in the third part about their past flood experiences prior to the 2022 flood., if their current location was safe from flooding, if they had been injured or ill from the recent flash flood if they had lost a family member, and if they had income problems. This research examined if the flood damaged property. We utilized participant demographics and flood data as independent variables. We anticipated these factors would affect all three DASS components. We then asked DASS-21 questions. Self-reported questionnaires were initially developed (34). Most participants were illiterate or uneducated. We asked questions to get self-reported answers. In certain research, DASS-21 was utilized in face-to-face interviews (40–42). We utilized a tested Bengali form of DASS-21 (43). In our earlier study, we used this tool successfully with the general community during COVID-19 (36). Participants understood our questions. We’ve worked with these participants (44). Our pilot survey also enhanced question clarity.

2.4 Data management

Participants for this study were selected using a combination of convenience and snowball sampling techniques. Initially, we approached adult male residents (aged 18 years or older) from Ajmiriganj and Dharmapasha Upazilas who had been directly affected by the 2022 flash flood. The first participant was identified through community contacts and local key informants. Following this, snowball sampling was used, where each respondent was asked to refer other potential participants who met the study criteria. In the convenience sampling technique, participants were selected based on their availability and willingness to participate. This method facilitated quick data collection from those directly affected by the flood. In the case of the snowball sampling technique, initial participants referred other potential respondents from their social networks, ensuring a broader representation of affected individuals. The sample size was determined using Krejcie and Morgan’s (45) table, which provides an established guideline for selecting an appropriate number of respondents. For a population exceeding 10,000 individuals, a sample size of 384 participants is deemed statistically adequate. To enhance reliability and account for potential non-responses, we increased the sample size to 452 participants.

2.5 Data analysis

Data analysis was conducted using R software (version 4.2.2) and Python (version 2.7) (46, 47), following a two-step regression approach. First, simple linear regression (bivariate analysis) was performed, where each independent variable was tested separately against the three mental health outcomes—depression, anxiety, and stress—to identify significant associations ($p < 0.05$). In the second step, multiple linear regression (multivariate analysis) was conducted, incorporating only those variables that were statistically significant in

TABLE 1 Cutoff values for DASS-21 depression, anxiety, and stress labels (34).

Severity label	Depression	Anxiety	Stress
Normal	0–9	0–7	0–14
Mild	10–13	8–9	15–18
Moderate	14–20	10–14	19–25
Severe	21–27	15–19	26–33
Extremely severe	28+	20+	34+

the bivariate analysis. Three separate multiple linear regression models were developed, with depression, anxiety, and stress as the respective dependent variables. Each model included selected sociodemographic and flood-related factors as independent variables to assess their associations with mental health conditions. The results were reported using beta coefficients (β), confidence intervals (CI), and p -values to determine statistical significance.

2.6 Ethical issues

An ethical certification committee associated with Khulna University in Bangladesh has approved this research (Ref. No. KUECC-2022/06/16) after reviewing our objectives and method. This study followed the Declaration of Helsinki and its revisions regarding human subject usage (48). Informed consent was obtained from all participants. For those who were illiterate, consent was verbally explained in Bengali, and their agreement was documented with their permission.

3 Results and discussion

3.1 Sample profile

Table 2 presents the sociodemographic data of the study participants. Approximately 33% of the sample population was between 36 and 55 years old, followed by 24% in the 18–35 age group, with the remaining participants spread across other age groups. The majority (94%) of participants were married. A significant portion of the population was illiterate or had not completed secondary school, which aligns with the low male literacy rates reported in previous Upazila data (27). Our findings, similar to prior research (49), confirm that men in this area tend to have higher education levels than women. Previous studies indicated that 74% of women in these Upazilas are uneducated (49). Most participants lived in semi-pucca dwellings, and more than half of them were employed as agricultural farmers or fishermen.

Table 3 summarizes the flood-related facts and impacts. A significant number of participants had experienced floods before the 2022 event. Around 55% of participants considered their homes vulnerable to flooding, which is consistent with the regular flooding in these areas (50). They are generally well aware of local flood risks. The 2022 flash flood caused injuries to 13 and 10% of participants' families. Furthermore, 92% of participants or their families lost income due to the flood, and 95% reported damage to their property. It aligns with a similar report detailing the impacts of the 2022 floods in the region (51). Despite these hardships, most participants received financial and social assistance during the flood event.

3.2 Mental health status

The findings presented in Figure 2 shed light on the mental health status of the research participants, focusing on levels of depression, anxiety, and stress. The mean scores for depression (19.96 ± 8.19), anxiety (14.51 ± 8.6), and stress (22.12 ± 8.98) indicate significant psychological distress among the respondents. Table 4 further

TABLE 2 Sociodemographic information.

Features	Frequency (%)
1. Age group (year)	
18–35	110 (24.34)
36–45	148 (32.74)
46–55	98 (21.68)
>55	96 (21.24)
2. Marital status	
Married	424 (93.81)
Unmarried	28 (6.19)
3. Education	
Illiterate	208 (46.02)
Non-SSC	208 (46.02)
SSC or above	36 (7.96)
4. Location	
Ajmiriganj	281 (62.17)
Dharmapasha	171 (37.83)
5. Housing type	
Kacha ^a	34 (7.52)
Pucca ^b	18 (3.98)
Semi-pucca	400 (88.50)
6. Occupation	
Agri farmers or Fishers	293 (64.82)
Business	71 (15.71)
Government or private Employee	9 (1.99)
Daily labor	17 (3.76)
Others	11 (2.43)
Unemployed	51 (11.28)
7. Vulnerable family member (child, pregnant woman, older person, etc.)	
Yes	411 (90.93)
No	41 (9.07)
8. Chronic disease	
Maybe	10 (2.21)
No	331 (73.23)
Yes	111 (24.56)
9. Social satisfaction	
Least Satisfied	95 (21.02)
Satisfied	354 (78.32)
Very Satisfied	3 (0.66)

Kacha^a = refers to buildings or structures made with temporary or less durable materials such as bamboo, mud, or thatch. These are typically less resistant to floods and other disasters; Pucca^b = refers to structures or buildings that are made with durable, permanent materials like brick, concrete, or stone. These buildings are considered more stable and resilient to environmental factors.

highlights the severe psychological impact of the flood. Approximately 24 and 23% of participants experienced severe or extremely severe depression, respectively, pointing to a significant number of individuals struggling with depressive symptoms. Around 33% of participants reported severe anxiety, indicating a high prevalence of

TABLE 3 Flood-related information.

Features	Frequency
1. Do you have pre-2022 flood experience?	
No	5 (1.11)
Yes	447 (98.89)
2. How safe is the area from flooding?	
Moderately Safe	189 (41.81)
Safe	13 (2.88)
Unsafe	250 (55.31)
3. Have you been injured or sickened by the 2022 flash flood?	
No	393 (86.95)
Yes	59 (13.05)
4. Do any family members have injuries or diseases from the 2022 flash flood?	
No	405 (89.60)
Yes	47 (10.40)
5. Did you lose any family members in the 2022 flash flood?	
No	446 (98.67)
Yes	6 (1.33)
6. Has the 2022 flash flood harmed your or your family's income?	
No	38 (8.41)
Yes	414 (91.59)
7. Was your property damaged by the 2022 flash flood?	
No	23 (5.09)
Yes	429 (94.91)
8. Have you obtained social or economic aid during the 2022 flash flood?	
No	66 (14.60)
Yes	386 (85.40)

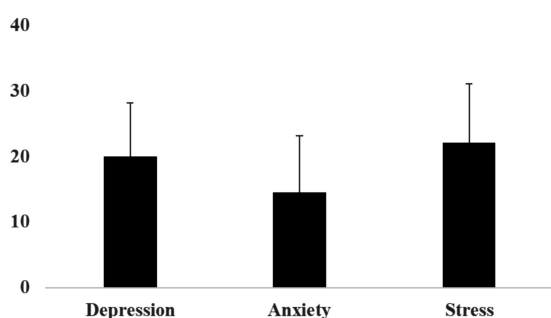


FIGURE 2 Mean and standard deviation of depression, anxiety, and stress score.

TABLE 4 Depression, anxiety, and stress labels in men of study areas.

Severity label	Depression [n (%)]	Anxiety [n (%)]	Stress [n (%)]
Normal	53 (11.73)	106 (23.45)	110 (24.34)
Mild	58 (12.83)	50 (11.06)	75 (16.59)
Moderate	130 (28.76)	106 (23.45)	105 (23.23)
Severe	108 (23.89)	42 (9.29)	91 (20.13)
Extremely Severe	103 (22.79)	148 (32.74)	71 (15.71)

anxiety-related distress among men. Additionally, 20 and 16% of respondents experienced severe or extremely severe stress, respectively, further illustrating the widespread stress among participants in the aftermath of the flood.

These findings are consistent with previous studies on men's mental health following natural disasters such as floods. Cultural values of stoicism and self-reliance may discourage men from seeking mental health support, potentially exacerbating their suffering (52, 53). The high prevalence of severe mental health symptoms among men underscores the urgent need for targeted mental health treatments and support services in disaster-affected areas.

Men may also experience additional stress due to their societal roles as providers and caretakers. The loss of livelihoods, displacement, or struggles to meet family responsibilities can further strain their mental well-being (53). As a result, men in disaster-affected regions may experience depression, anxiety, stress, and PTSD. Our findings align with broader disaster mental health literature, which suggests that men and women experience psychological distress differently. Women typically exhibit higher rates of PTSD, depression, and anxiety due to heightened emotional processing of trauma. In contrast, men are more likely to manifest stress through externalizing behaviors, such as substance use and avoidance. The high levels of severe depression and anxiety observed in this study reinforce the need for targeted mental health interventions that consider gender-specific coping mechanisms and barriers to seeking psychological support.

A different study on women's mental health post-disaster found higher levels of depression, anxiety, and stress compared to the results in this study (49). While men may not experience mental health difficulties as severely as women, their challenges also require attention for the sake of community resilience. In countries with entrenched gender equality through legislative frameworks, research suggests that both men and women should face similar disaster-related mental health outcomes (54). For instance, the 2007 Tewkesbury floods and the 2008 Morpeth floods in the UK demonstrated that men and women may experience both common and distinct gendered impacts from disasters (54). Similarly, the English National Study on Flooding and Health found that women had comparable risks of depression and anxiety as men (55). After Hurricane Katrina, 15% of men in the affected areas reported depression (56). In some cases, men expressed feelings of fear and referred to the floods as "very severe" (54).

3.3 Associated factors with depression, anxiety, and stress

Table 5 outlines the Disaster-Related Adjustment and Stress (DAS) factors. In line with the method used in this study, only statistically significant variables were included in the simple linear regression analysis. Significant variables included age group, education, marital status, housing type, occupation, chronic disease, social satisfaction, prior flood experience, flood safety ratings, income loss due to the flood, property damage in the 2022 flood, and receiving social and economic support during the flood. Multiple linear regression analyses indicated that depression was significantly associated with age, marital status, housing type, occupation, flood safety ratings, and property damage in the 2022 flood.

TABLE 5 Associated factors with DAS.

Features		β# (95% CI)		
		Model I Depression	Model II Anxiety	Model III Stress
1. Age range (in year)	18–35	−1.26 (−3.49; 0.95)	−0.74 (−3.14; 1.64)	−0.64 (−3.16; 1.87)
	36–45	−2.02 (−4.02; −0.02)*	−0.65 (−2.79; 1.47)	−0.89 (−3.14; 1.35)
	46–55	−1.11 (−3.21; 0.97)	−0.42 (−2.64; 1.80)	0.66 (−1.67; 3.01)
	>55			
2. Marital status	Married			
	Unmarried	−4.73 (−7.66; −1.80)**	−4.01 (−7.16; −0.87)*	−5.06 (−8.36; −1.76)**
3. Education	Illiterate			
	Non-SSC	−0.47 (−1.92; 0.97)	−1.80 (−3.43; −0.17)*	−1.84 (−3.55; −0.14)*
	SSC or above	−0.35 (−3.02; 2.31)	−1.19 (−4.08; 1.69)	−1.50 (−4.51; 1.51)
4. Location	Ajmiriganj			
	Dharmapasha		−0.32 (−2.08; 1.42)	1.53 (−0.30; 3.37)
5. Types of housing structure	Kacha			
	Pucca	−6.74 (−10.83; −2.64)**	−6.58 (−10.98; −2.18)*	−5.59 (−10.18; −1.00)*
	Semi-pucca	−0.35 (−2.73; 2.01)	−2.40 (−4.95; 0.14)	−0.62 (−3.28; 2.03)
6. Occupation	Agri farmers or fishers			
	Business	−3.74 (−5.55; −1.93)***	−2.42 (−4.37; −0.46)*	−4.19 (−6.23; −2.15)***
	Government or private employee	−5.84 (−11.67; −0.01)*	−5.33 (−10.74; 0.08)	−7.91 (−14.35; −1.47)*
	Daily labor	−0.78 (−4.08; 2.50)	−2.17 (−5.77; 1.41)	−1.98 (−5.73; 1.75)
	Others	−1.86 (−6.03; 2.30)	0.85 (−3.66; 5.37)	−1.56 (−6.28; 3.15)
	Unemployed	1.25 (−1.30; 3.81)	0.30 (−2.41; 3.03)	−3.97 (−7.09; −0.84)*
7. Chronic disease	Maybe			
	No	0.48 (−3.80; 4.77)	1.61 (−3.00; 6.23)	1.33 (−3.52; 6.19)
	Yes	1.97 (−2.48; 6.43)	4.02 (−0.80; 8.85)	1.83 (−3.21; 6.88)
8. Social satisfaction	Least satisfied			
	Satisfied	−1.17 (−2.74; 0.40)	0.25 (−1.43; 1.94)	−0.46 (−2.22; 1.29)
	Very satisfied	1.61 (−6.44; 9.68)	−1.37 (−9.82; 7.07)	−2.91 (−11.96; 6.12)
9. Do you have pre-2022 flood experience?	No			
	Yes	−0.62 (−6.87; 5.61)		
10. How safe is the area from flooding?	Moderately safe			
	Safe	−0.50 (−4.55; −3.54)	1.44 (−2.90; 5.79)	1.36 (−3.20; 5.93)
	Unsafe	5.99 (4.63; 7.35)***	6.55 (5.03; 8.08)***	7.05 (5.45; 8.65)***
11. Has the 2022 flash flood harmed your or your family's income?	No			
	Yes	−0.53 (−3.36; 2.30)		−0.36 (−3.56; 2.82)
12. Was your property damaged by the 2022 flash flood?	No			
	Yes	4.29 (1.16; 7.41)**		2.35 (−1.13; 5.84)
13. Have you obtained social or economic aid during the 2022 flash flood?	No			
	Yes	0.04 (−1.90; 1.98)	1.30 (−0.79; 3.40)	0.23 (−1.97; 2.45)

*p < 0.05, **p < 0.01, ***p < 0.001; β# = Beta (Coefficient). CI, confidence interval.

Participants in the 36–45 age group, unmarried individuals, those living in pucca (brick) houses, those engaged in business activities or employed in government or private sectors, and individuals who rated their areas as moderately safe from flooding and had not suffered property damage were less likely to experience depression than those in the over-55 age group, married individuals, those residing in kacha (temporary) houses, and those working as fishermen or farmers, particularly if they perceived their areas as unsafe from floods or had experienced property damage in previous floods, including the 2022 event.

Anxiety was found to be associated with marital status, education, housing type, occupation, and flood safety ratings. Unmarried participants, those with less than secondary school education, those living in pucca houses, businesspeople, and those who rated their areas as moderately safe from flooding reported lower levels of anxiety compared to married individuals, those with no formal education, those residing in kacha houses, and those working in agriculture or fishing, particularly in areas rated as unsafe.

Stress was associated with all anxiety-related factors. Unmarried participants, those with less than secondary education, those living in

pucca houses, businesspeople, government or private employees, and those living in moderately safe locations were less likely to experience stress compared to married individuals, those with no formal education, those residing in kacha houses, and those involved in agriculture or fishing, particularly in unsafe areas.

The impact of sociodemographic factors on mental health post-floods is clear. These factors significantly affect mental health outcomes in the aftermath of disasters. Floods, due to their recurring nature and severity, can exacerbate mental health problems, especially among vulnerable groups, such as people with low incomes (57). These communities, often dependent on agriculture or fishing, suffer significant losses of livelihoods, which compounds mental health distress. Flooding is one of the most damaging agricultural disasters, leading to crop failure and decreased productivity (58, 59). It also disrupts water quality and habitat structures, which adversely affect fishing (60, 61). Thus, the mental health challenges observed in our study can be attributed to the destruction of livelihoods caused by the 2022 floods.

Identifying these key sociodemographic characteristics allows authorities, public health professionals, and disaster management experts to better target interventions for vulnerable populations. Understanding the root causes of mental health disorders is crucial. Older individuals may have experienced multiple disasters over time, leading to increased mental health concerns (62, 63). Older people are particularly vulnerable to the impacts of disasters, often facing increased risks due to diminished physical health and social isolation (64, 65). Research suggests that older adults are more likely to suffer from mental health problems in the wake of a disaster (66–69).

The DAS factors also reveal the role of inadequate education, housing quality, and the safety of living environments in shaping mental health outcomes. Mental illness places a heavy burden on individuals, families, and communities (70). Low socioeconomic status is linked to higher rates of mental health issues (71). The mismatch between demands and available resources often triggers stress responses. People with low incomes face greater health risks yet lack the resources to mitigate them (72). Limited response resources in poor communities increase vulnerability to stress, conflict, and hazardous conditions (73), leading to long-term mental health consequences.

Illiterate individuals may be less aware of disaster risks and less able to respond effectively (74). Studies show that education plays a critical role in enhancing resilience and mental health post-disasters (75–77). Nations with higher levels of income and education typically experience fewer losses during disasters (78). It raises questions about whether financial stress contributes to mental health problems in low-income populations or whether education plays a more significant role in fostering resilience (79). Education can improve awareness of disaster risks, disaster preparedness, and access to resources (75). In contrast, inadequate disaster response, especially in flood-prone areas, may lead to increased mental health symptoms. Different regions experience varying levels of flood damage depending on housing quality and the vulnerability of exposed elements (80). Participants living in kacha houses, for example, were found to have higher levels of depression, anxiety, and stress compared to those living in pucca houses, likely due to the hazardous conditions associated with kacha housing.

Overall, our findings demonstrate that the mental health issues experienced by participants are directly related to the losses suffered during the 2022 floods. As loss from disasters can exacerbate mental health challenges, it is crucial to prioritize both disaster risk mitigation

and post-disaster mental health care. The mental health impacts of floods are significantly influenced by community resilience. Resilient communities tend to experience fewer mental health problems post-flood (81). Several factors, such as traumatic events, disruptions to daily life, the loss of loved ones, and the destruction of homes and assets, can contribute to the increase in mental health issues (82).

3.4 Recommendations

Based on our findings, we propose the following recommendations for local and national governments, as well as disaster management and public health authorities, to mitigate the mental health impact of floods:

3.4.1 Strengthening mental health support in disaster response

Mental health services should be integrated into emergency response programs, focusing on high-risk groups identified in this study, including older individuals, those in unsafe housing, and agricultural workers. Healthcare workers and community volunteers should receive training in Psychological First Aid (PFA) to provide immediate post-disaster mental health support. Additionally, public awareness campaigns should be expanded to reduce the stigma surrounding mental health issues among men, encouraging them to seek help when needed.

3.4.2 Targeted mental health interventions

Specialized mental health programs should be developed for flood-affected men, particularly those with lower education levels and precarious livelihoods. Access to counseling and psychosocial support services should be enhanced through mobile health clinics, especially in remote flood-prone areas where traditional healthcare access is limited. These interventions should be tailored to address the unique psychological challenges faced by men in disaster settings.

3.4.3 Improving flood preparedness and housing resilience

Early warning systems should be strengthened to ensure timely flood alerts, reducing uncertainty and psychological distress among vulnerable populations. In addition, housing improvement programs should be implemented to support the transition from kacha (temporary) housing to more resilient structures, thereby mitigating future mental health risks associated with displacement and property loss.

3.4.4 Enhancing socioeconomic recovery programs

Targeted financial aid and livelihood recovery initiatives should be provided to support flood-affected men, particularly those in high-risk occupations. Microfinance and vocational training programs should be promoted to diversify income sources and reduce economic vulnerabilities. Ensuring financial stability post-disaster can play a critical role in reducing long-term psychological distress and supporting mental health recovery.

3.4.5 Integrating mental health into disaster policy

Mental health considerations should be incorporated into Bangladesh's national disaster risk reduction strategies to ensure

comprehensive disaster response planning. Additionally, long-term mental health monitoring programs should be established in flood-prone areas to track and address persistent psychological effects. This approach will help policymakers and practitioners develop effective strategies to mitigate mental health challenges in future disaster events.

4 Strengths and limitations

This study successfully assessed the prevalence and associated factors of depression, anxiety, and stress among flood-affected men, identifying statistical associations between flood exposure and mental health outcomes. However, the research has certain limitations. The use of convenience and snowball sampling may have introduced selection bias, and the data collection timeframe was predefined, restricting broader generalization. The cross-sectional design captures associations at a single time point but does not establish causal relationships between flooding and mental health distress. Additionally, due to widespread illiteracy, only straightforward inquiries were made. The study focused solely on male casualties of the 2022 flash flood, excluding men who remained unharmed. Despite these limitations, this baseline survey provides valuable insights for ongoing research on disaster-related mental health concerns. Future longitudinal studies could help confirm the long-term psychological impact of floods. Moreover, the study's findings can inform disaster risk reduction strategies, aiding officials in developing more effective flood recovery and preparedness measures. Similar methodologies may also be applied to assess the mental health impacts of natural hazards across different regions, both nationally and internationally.

5 Conclusion

This study investigates the impact of the 2022 flash floods on men's mental health in two severely affected Upazilas of Bangladesh. Using the DASS-21 scale, we assessed the prevalence of depression, anxiety, and stress among flood survivors. Our findings indicate that a significant proportion of respondents experienced severe psychological distress, with sociodemographic and flood-related factors playing a crucial role. Older age, lower education levels, unsafe housing conditions, and employment in agriculture or fishing were associated with higher mental health burdens. The study underscores the importance of addressing mental health challenges in disaster response and preparedness efforts. While the findings provide valuable insights, they also highlight the need for further research, particularly longitudinal studies, to assess long-term psychological impacts. Additionally, the study's reliance on self-reported data and cross-sectional design limits causal interpretations. Future research should explore gender-specific coping strategies and resilience factors to better inform mental health interventions in disaster-prone areas.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Khulna University in Bangladesh has granted approval for this research (Ref. No. KUECC-2022/06/16). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MR: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. IS: Conceptualization, Data curation, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. MTH: Conceptualization, Visualization, Writing – original draft, Writing – review & editing. EA: Conceptualization, Visualization, Writing – original draft, Writing – review & editing, Investigation. MI: Conceptualization, Visualization, Writing – original draft, Writing – review & editing, Investigation. MKH: Conceptualization, Writing – original draft, Writing – review & editing, Investigation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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